Hiroshi INOUE*: **Studies on spore germination of Hepaticae (3)****

Brachiolejeunea sandovicensis (Gott.) Evans and

Frullania hamatiloba Steph.

井 上 浩*: 苔類の胞子発芽 (3)** チヂレウロコゴケと

カギフルラニゴケ

The family Lejeuneaceae includes many genera and is one of the most difficult groups. Phylogenetic relationships between those genera are rather complicated, and only by morphological aproach it may be unable to obtain a satisfactory evolutional system of this family. The sporeling pattern, which is generally thought to indicate, in some degree, the phylogenetic relationships between higher taxonomic groups of Hepaticae, may also serve to define the affinities of genera of the Lejeuneaceae. Unfortunately, however, the number of the data on the sporelings is very small compared with a large number of the genera of this family. As a reason of such scantiness of the data, it may be considered that much difficulties are present throughout on the spore-culture of this family, aed similar cases also exsist in the Frullaniaceae.

M. Fulford published many excellent papers on the sporelings of the Lejeuneaceae. She distinguished six types of the sporelings in this family, Lophoejeunea-type, Leuconejeunea-type, Lejeunea-type, Ceratolejeunea-type, Stictolejeunea- and an unnamed type, and most of them contained few species. For *Frullania* she proposed Frullania-type based on *Frullania dilatata*, and included in it two species, *Porella platyphylla* and *Lepidolaena clavigera*, belonging to different families. In this paper the writer wishes to discuss on the phylogenetic evaluation of the patterns of Frullania-type and Lopholejeunea-type, from the studies on *Brachiolejeunea sandvicensis* and *Frullania hamatiloba*.

In July of 1956 the writer collected some materials of *Brachiolejeunea sandvicensis* and *Frullania hamatiloba* in the Chichibu Mountains, Saitama Pref. They have fully developed perianths which embeded young sporophytes. These materials were culture for about a month before maturity of the sporophytes. Some matured sporophytes were cut off and transferred on a sheet of purified paper. Capsules expanded in a few hours and spores were scattered. The spores were sown on Knop's agar on the same day.

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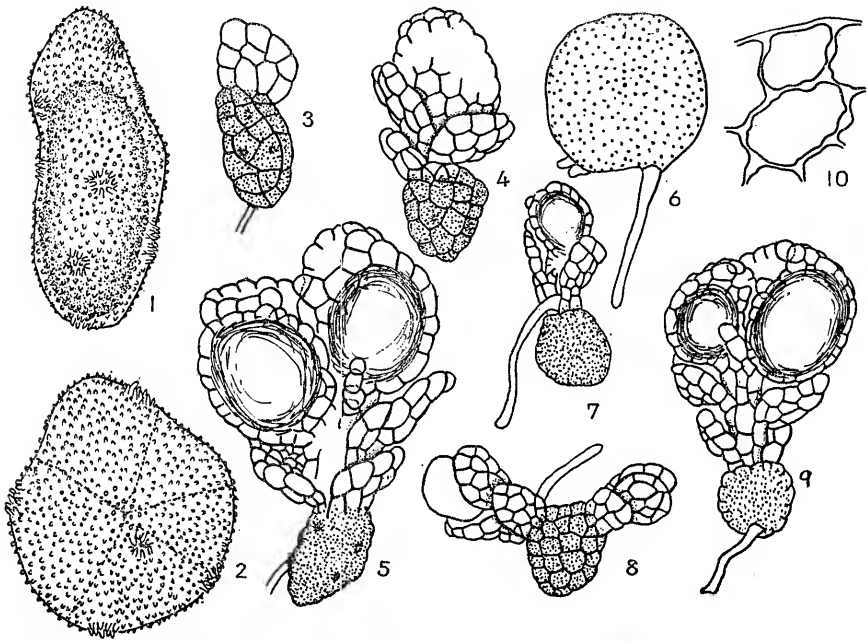
Germination

Spores in a matured capsule of *Brachiolejeunea sandvicensis* are usually in 2-4 celled stage of development, but some of them still remain in unicellular stage (fig. 1-2). Spores in this stage are very much irregular both in form and size. The



Figs. 1-10. Various stages of the sporelings in *Brachiolejeunea sandvicensis* (1-5) and *Frullania hamatiloba* (6-10). Figs. 1, 2, and 6, ×360; 10, ×900; the others, ×160. For explanation of figures see text.

measurement is 80-110×40-55 μ. The spore coat has many papillae and some series of coaser papillae arranged in roughly circular pattern. The endospore is richly chlorophyllous and contains numerous minute oil-drops which are stained by Sudan III. Usually the endospore is not homogeneously green, and a deep green mass of chloroplasts is situated at one side of the endospore. This feature of the spore, however, is seen generally in uni- or bicellular stage. But in a further developed stage, it becomes homogeneously deep green. The first wall is formed at right angles to the long axis.

In *Frullania hamatiloba* the spores have minutely and uniformly punctated coat. Before the expansion of the spore coat about 30 or a little more cells are formed

within the exospore. In this case the measurement of the spore is approximately 70 μ. Many oil-drops and chloroplasts are contained in the exospore. But in a more earier stage of development the green-mass of the chlorophasts as seen in *Brachiolejeunea sandovicensis* was not observed.

The following developmental patterns of both species were observed in the sporelings which appeared among the cultured mat of *Brachiolejeunea sandvicensis* growing on the bark of *Fagus crenata*, and of *Frullania hamatiloba* gsowing on the bark of *Quercus mongolica* var. *grosserrata*.

In *Brachiolejeunea sandvicensis*, before the expansion of the coat 15-20 cells are formed within the exospore (figs. 3-4). The 1-(2) rhizoids developed from the radiating ridge of coaser papillae before the liberation of the primary leaf. The plane and orbicular primary leaf developed from a side of the exospore whereto the green mass of chloroplasts was situated in an earier stage, and the rhizoids developed from the opposste side to the primary leaf along the axis. Thus the situation of the green mass of the chloropalsts in an earier stage seems to indicate the presence of polarity in the sporeling.

The plane and orbicular primary leaf is usually 3 in number. The third primary leaf is followed by the juvenile leaves with a large and strongly inflated ventral lobe (fig. 4-5). The dorsal lobe of the juvenile leaf is nearly same to the ventral one both in form and size. The ventral lobe (lobule) has 1-2-celled apical tooth and is strongly inflated. The primary underleaf is never produced at the stage of the primary leaf. The filiform primary underleaf composed of 3-4 cells is developed from the ventral side of the juvenile stem at the earier stage of the juvenile leaf.

The developmental pattern of the juvenile plant of *Frullania hamatiloba* is the same as that of *Brachiolejeunea sandvicensis*. The protonema of this species is globular without a distinct axis. The juvenile leaf has also much inflated ventral lobe which has unicellular apical tooth. The primary underleaf is also linear and composed of 2-3 cells. The cell walls of the primary leaf and the rhizoids are mostly right brown in color and not thickned. Those of the juvenile leaf are moderately thickened with distinct trigones as in the mature leaf (fig. 10). Occasionally two plants developed from a single protonema (fig. 8), but one of them may be more or less suppressed in growth.

In *Brachiolejeunea sandvicensis* a rather large number of oil-bodies (usually 30-35 per cell) are found in the cells of the primary leaf and stem. The oil-bodies are 1-2 in diameter, homogeneous, and never stained by Sudan III. Occasionally in

the basal cells of the primary leaf 2–3 large oil-drops were observed. The oil-bodies are nearly similar to those of adult plant but far smaller. The oil-bodies of the juvenile plant of *Frullania hamatiloba* are also very similar to those of adult plant except for their size.

Gemmae of *Brachiolejeunea sandvicensis* and *Frullania hamatiloba* are not found. The vegetative reproduction from leaves could not be obtained in culture, nor found among the mats of herborium specimens.

Discussion and conclusion

From the above observations it may be said that the pattern of the sporelings of *Brachiolejeunea sandvicensis* is similar to that of Lopholejeunea-type, and *Frullania hamatiloba* to Frullania-type. The former pattern is known in some species *Lopholejeunea*, *Mastigolejeunea*, and *Archilejeunea*. However, according to the writer's observations, the pattern of *Frullania hamatiloba* is much allied to that of Brachiolejeunea sandvicensis. M. Fulford distinguished the patterns of Frullania-type from that of Lopholejeunea-type by the number of the cells within the exospore; four to dozen in Lopholejeunea-type and 50 or more in Frullania-type. However, the number of the cells within the exospore seems not to be estimated so essential as she considered.

At the earier stage of the development of *Brachiolejeunea sandvicensis*, the spore usually elongates and also the protonema more or less elongates and shows a oval form in outline. Thus, throughout the development of the protonema, the presence of the developmental axis may be indicated. The protonema with distinct developmental axis is usual throughout for the Lejeuneaceae, at least according to the present knowledge on the sporelings of this family. On the other hand, in Frullania-type the protonema is globular and has no distinct axis. The abnormal developmental pattern of *Frullania hamatiloba* shown in fig. 10 may be an example which indicates this fact.

The developmental pattern of the juvenile plant of Lopholejeunea-type is almost the same to that of Frullania-type. The number of the cells within the exopsore of Frullania is smaller than M. Fulford's consideration. From the above discussion the difference between the pattern of Lopholejeunea-type and that of Frullania-type may lie in the protonema form.

R. M. Schuster (1955) discussed the close relationship of the Lejeuneaceae to the Frullaniaceae from the morphological studies of the sporophytes. This is also

admitted from the sporeling patterns in both families. Among the Lejeuneaceae, the subfamily Holostipae, to which all genera of the Lopholejeunea-type belong, is considered as the most primitive group by R. M. Schuster. Separately from this opinion, the writer thinks that the Holostipae has particular affinity to the Frullaniaceae from the sporeling pattern, especially by the almost similar developmental pattern of the juvenile plant.

Summary

Sporeling patterns of *Brachiolejeunea sandvicensis* and *Frullania hamatiloba* are discussed; the former species is followed to Lopholejeunea-type and the latter to Frullania-type. The essential difference between both patterns lies in the protonema form; oval one with a distinct developmental axis in Lopholejeunea-type and globular one without axis in Frullania-type. The former type of the protonema is usual for the Lejeuneaceae. From the similar pattern of the development of the juvenile plant in Frullania- and Lophonelejunea-type, the closest relationship of the Holostipae of the Lejeuneaceae to the Frullaniaceae is indicated.

The writer should like to express his cordial thanks to Prof. H. Ito of our University and Dr. S. Hattori of the Hattori Botanial Laboratory for their kind and useful advices.

Literature

M. Fulford. Bull. Torrey Bot. Club **69**: 627-633 (1942). —— Bryol. **45**: 173-175 (1942). —— Bull. Torrey Bot. Club **71**: 639-654 (1944). —— Bryol. **50**: 97-112 (1947). —— Rev. Bryol. Lich. **18**: 14-18 (1950). —— VIII Congr. Intern. Bot. Rapp. et Comm. Sect. **16**: 55-64 (1954). R. M. Schuster. Journ. Elisha Mitchell Sci. Soc. **7**: 106-126 (1955).

クサリゴケ科 (Lejeuneaceae) の胞子発芽は主として M. Fulford によつて研究され，六つの型に分けられた。このうち Lopholejeunea 型はヤスデゴケ科 (Frullaniaceae) およびその他の二つの異なる科にみられる Frullania 型から，胞子内で形成された原糸体を構成する細胞の数が，前者では 50 以上，後者では 12 以下であることによつて区別された。今回筆者はチヂレウロコゴケ (*Brachiolejeunea sandvicensis*) およびカギフルラニゴケ (*Frullania hamatiloba*) の 2 種類で研究した結果，前者は Lopholejeunea 型に，後者は Frullania 型であることが明かとなつた。しかし M. Fulford が考えた如く原糸体の細胞数がこの二つの型を分ける基本的なものでないことが明かとなつた。すなわち Lopholejeunea 型では原糸体は明かな長軸を有し，従つて原糸体の外形は楕円

状になるが，Frullania 型ではこのような軸は認められなく，原糸体は球状となる。このような原糸体の形の相異はヤスデゴケ科およびクサリゴケ科の全体的な相異ともなる。従つてこの二つの発芽形の相異は原糸体の形の相異（または明かな発芽軸があるかないか）。にあると考えられる。

原糸体からの幼植物の発達過程は二つの型で全く同様である。このことからクサリゴケ科の中でも Holostipae 亜科（Lopholejeunea 型のものはすべてこの亜科に属する）とヤスデゴケ科の近縁関係が証明されると考えられる。

○ヌカボガエリについて（檜山庫三） Kōzō HIYAMA: On *Polypogon hondoensis* Ohwi

大井次三郎博士も既に云われているようにヌカボガエリ（*Polypogon hondoensis* Ohwi）はヒエガエリとコヌカグサとの間に出来た自然雑種に違いないと思える。これまで，この植物は本州の青森・富山・長野の 3 県で発見されていたが，今度（1957 年 4 月 14 日）群馬県前橋市の岩神河原で戸部正久氏が採集された。戸部氏の標本では lemma に明かな芒があつて，その長さは小穂より僅に超出するか少し短い。しかし，lemma に芒の出る出ないはこの場合は多分雑種性のしからしむるところであろうから，この点問題はないと思う。雑種では個体によつて両親のどちらかの形質がより強く現われることがあるが，前橋産のものはコヌカグサの形質の方が一層強く現われており，その片親のコヌカグサとハイコヌカグサに近い型のものだつたように想われる。また包穎の背は多かれ少かれ稜をなしていて，その側面には一面に微細な刺状突起のあるのがルーペで見られる。

×**Agropogon hondoensis** (Ohwi) Hiyama, comb. nov.

Polypogon hondoensis Ohwi in Bot. Mag. Tokyo **55**: 357 (1941).

Agrostis palustris Huds. × *Polypogon fugax* Steud.

Distr. Hondo: Mutsu, Ettyu, Shinano et Kodzuke.

○イモネラン九州に産す（久内清孝） Kiyotaka HISAUCHI: *Eulophia ochobiensis* Hayata has been collected in Kyushu.

イモネランが九州に産することについては，現地の人達には，わかつているかも知れないが，流布されている文献や，東京大学，科学博物館の収蔵標本では証明できない。ところが，千葉大学教授荻庭丈美氏は昨年 7 月，これを宮崎県辺塚の叢中で得られた。鑑定は私がしたので，更にラン科の専門家を煩す必要があるが *Eulophia* 属であることはたしかである。東京には早田博士のタイプの外，西南諸島からの標本はかなりあるので，それ等と比較するとイモネランということになる。そうして，津山氏が小笠原でかかれたイモランとは少し異るようであるが，私はまた比較解剖をしていない。